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A
DISCUSSION
OF SOME
Important *and* Uncertain Points
IN
CHRONOLOGY,
IN A
SERIES of LETTERS,

Addreſſed to the Rev^{d}. Dr. BLAIR,

Prebendary of WESTMINSTER.

Perlege quodcunque eſt : quid Epiſtola lecta nocebit ?
Forſan in hâc aliquid quod juvet eſſe poteſt.
OVID.

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G.R III
BRITISH MUSEUM

PREFACE.

THE primary deſign of the following Calculations is to prove, not only that there is a metachroniſm of 4 years in Abp. Uſher's Chronological Computations, but, which is more eſpecially to be obſerved, of juſt 4 years; neither one year more, nor one year leſs; ſo that this ſeemingly ſmall miſtake, in the collection of the years, being rectified, the true year of the world will be immediately eſtabliſhed; and by this means a moſt perplexing difficulty, in the general ſyſtem of chronology, which for ages paſt has been productive of ſo many fruitleſs wranglings and diſputes, will be happily and finally ſolved.

There is a great propriety in this addreſs to Dr. Blair, he having aſſumed theſe very computations for the baſis of his Tables, which make a ſhow, at leaſt, of filling up the whole interval from the year of the creation to the preſent times: but however inconſiderable a miſtake of 4 years, in a ſeries of more than 5700, may be thought, they will be ſufficient to deſtroy, and neceſſarily muſt deſtroy, all aſtronomical ſynchroniſms throughout his tables; which will leave no other excellency to recommend them, but that of their external beauty; whereas external beauty alone, will ſoon fade in the eye of a judicious examiner.

I now therefore call upon our learned and ingenious Chronologiſt, either to vindicate his adopted ακεφελαιον συστημα from this derogatory imputation, or to acknowledge its truth.

A metachroniſm of 4 years will put the ſun and moon quite out of their courſes, and interrupt the aſtronomy of the whole ſeries of years: it is ſuch a reproach to the Univerſal Syſtem of Aſtronomical Chronology unfolding the Scriptures, as cannot be diſpenſed with; and therefore it ought to be given up, or defended.

The argument by which I undertake to prove this charge, is as follows.

Ptolemy has recorded, in his Almegiſt, ſeveral lunar eclipſes, and, conſequently, as many coincidencies of a full moon, with a given month and day of the vague and erratic Egyptian ſolar year. I ſhall ſelect three examples, which may be thought ſufficient.

Example I. Almeg. L. iv. c. 6. A full moon fell upon the 29th of Thoth, an. ær. Nabonaſſ. 27. A. M. 3287 Uſher A. M. 3283; difference 4 years.

Example II. Almeg. L. v. p. 125, Græc. Edit. A full moon fell upon the 27th of Athyr, an. ær. Nabonaſſ. 127; A. M. 3387; Uſher A M. 3383; difference 4 years.

Example III. Almeg. L. iv. c. 11. A full moon fell upon the 10th of Meſori, an. ær. Nabonaſſ 547; A. M. 3807; Uſher A. M. 3803; difference 4 years.

Now, according to my calculations, even if we could ſuppoſe 19 years to be a true cyclic number, it would require a revolution of more than 27000 years to bring about the ſame coincidence, in the ſame ſeaſon of the fixed ſolar year; but as theſe are nearly more than four times the number of years that any of our four chronologies have reckoned to have paſſed ſince the creation, it neceſſarily follows, that theſe rare coincidencies muſt have their appropriated year of the world, in which only they can be found. To ſave trouble, I have pointed out theſe appropriated years, and have ſet down, together with them, the year of the world, as I found it in the margin of Uſher's Annals; in which no calculations can diſcover any one of theſe coincidencies: And from theſe ſure grounds I infer a deficiency of 4 years.

Whilſt I was caſting about in my mind, where I could meet with a perſon, who might be thought, by proper judges, to be unexceptionably well qualified to calculate theſe ſelected coincidencies, Mr. James Ferguſon opportunely occurred.

It is well known, that he has compiled and publiſhed a Treatiſe of Aſtronomy, both Speculative and Practical, upon Sir Iſaac Newton's principles of philoſophy; he has been, for ſome years paſt, our Table-maker in chief; he ſtill continues to teach aſtronomy to the public, and, in the general opinion, is a ſkilful artiſt. For theſe reaſons, it is greatly to be wiſhed, that thoſe gentlemen, who thought it worth their while to procure an act to be paſſed, not many ſeſſions ago, offering a reward for the improvement of the late Profeſſor Meyer's Lunar Tables, would likewiſe think it worth their while to engage ſuch a proficient to make the propoſed calculations: they would receive a very neceſſary and uſeful piece of information from the attempt; they would thereby be effectually convinced, that, ſtrictly ſpeaking, we have, at preſent, no ſolar and lunar tables at all; I mean none, which can with any degree of accuracy anſwer the ends for which they were originally intended, for more than 17 centuries paſt. But as experience is the beſt teacher, let an experiment be made.

It may be proper to obſerve here, that no more is required, upon this occaſion, than to aſcertain, by tabular calculation, the day of the month, both Egyptian and Julian, with the day of the week, on which the ſun came to the vernal or the autumnal equinox, as it happened to fall out in the given year from Nabonaſſar; and likewiſe the day of the month, both Egyptian and Julian, with the day of the week, on which the full moon happened, neareſt to the equinox; and to determine its diſtance, either before or after the cardinal point, in integral days.

Now, although theſe propoſed calculations are ſo extremely eaſy, the true principles being known, tha the three examples taken together will require the labour but of a ſhort ſpace of time; yet I will take upon me to aſſert, and with ſome degree of confidence too, that ſhould our calculator diſdain to plough with my heifer, he will find himſelf not a little embarraſſed; nay, I ſhall not ſcruple to add further, that the difficulties which will be ſure to occur in the courſe of the calculations (partly from the defect and imperfection of the tables, and partly from ſome other latent cauſes) will, for a while, appear inſuperable.

It would be quite frivolous to remark, what is ſelf-evident, and needs no proof, that it muſt needs be impoſſible, in the nature of the thing, to calculate one recorded circumſtance of an ancient eclipſe, until we are well able to aſcertain the day of the month, on the evening of which it was ſaid by Ptolemy to have been obſerved.

Now, moſt certain it is, for it may be inconteſtably proved, that no one recorded circumſtance, of any one of Ptolemy's eclipſes, has, in fact, ever been calculated yet, by our common tables; nor poſſibly can be, without the help of ſome previous inſtructions, and ſome neceſſary *præcognita*.

I will illuſtrate my meaning by an example.

Ptolemy has recorded, in his Almegiſt, an eclipſe of the moon (Example III.) viſible at Alexandria, in the year from Nabonaſſar 547. Mr. Ferguſon has attempted to calculate this eclipſe by his Tables, and found the true time of full moon to happen on the evening of the 22d of September, coincident (*ex hypotheſi*) with the 16th of Meſori: but the ſubjoined Table will exhibit to his view the true ſtate of the caſe, and direct him how to diſcover and to eſtimate his error, with reſpect to the calculated day of the Julian month.

The

The TABLE.

September. D.	Meſori. D.	Day of the Week.	
22	14	Friday.	4 days before ⊙ in ♎, and 2 days before full moon.
23	15	Saturday.	3 days before ⊙ in ♎, and 1 day before full moon.
24	16	Sunday.	2 days before ⊙ in ♎, and the day of full moon.

For the true grounds and reaſons of an unavoidable errror, relative to a true aſtronomical correſpondency of the Julian ſtyle with the Egyptian, ſee my Letter (No. VI.) to Dr. Blair. It is evident by inſpection, that Mr. Ferguſon has found an eclipſe, by his Tables, 2 days before there was any full moon in the heavens.

In the Table, the 22d of September is intuitively coincident with the 14th of Meſori; but it unluckily happens, that the moon was in that ſtation 2 days before the full. And yet we read, in Mr. Ferguſon's publications—of the obſcuration of 10 digits—of the hour and minute of the riſing of this *imaginary* full moon above the horizon of Alexandria, on the evening of this very day: nay, we read too—of its *parallactic depreſſion*—and of the *dimenſions* of its *diameter*—with ſome other mirabilia.

Such a mere farce, and ſuch a ridiculous, as well as ſhameful impoſition upon the intelligent reader, is tabular calculation, when carried back to the times of Ptolemy's eclipſes.

As it may poſſibly be of ſome ſervice to the induſtrious Mr. Ferguſon, I ſhall take this opportunity to inform him, that in the variety of examples which he has given in his ſeveral publications, the days of the month, on which the new moons and full moons happened, are miſcalculated, in every inſtance, where-ever the given year comes before the vulgar Chriſtian æra. And I dare pledge myſelf to prove, that if the Julian ſtyle be extended backwards to the year 201 A. C. no full moon can be found, by a true calculation, either on the 22d, or on the 23d of September in any one meridian of the globe; no, nor on the 24th of that month, at Alexandria, until after five o'clock in the evening. A regard to truth obliges me thus openly and publicly to impeach Mr. Ferguſon's Tables and calculations, of the enormous error, of more than forty hours with reſpect to the true time of this eclipſed full moon, as I find it ſet down at large, in his aſtronomical pamphlet, Example V. In the end of this pamphlet is inſerted a pretty large deſcant upon the various circumſtances of this imaginary and proleptical eclipſe; in which I find nearly as many errors, and ſome of them very groſs ones, as there are diſtinct articles and aſſertions: nor is there any other way, that I know of, to make him ſenſible of the truth of this well-grounded impeachment, but by calling upon him to calculate Ptolemy's eclipſes, in the Egyptian ſtyle, upon Ptolemy's data; as I have ſet him the example (as far as mean time of full moon is concerned) in my Letters to Dr. Blair.

It is a misfortune juſtly to be lamented, that practical aſtronomy, the moſt uſeful, although not the moſt ſublime branch of ſcience, ſhould have fallen into the hands, and, as it might ſeem, be negligently left to the ſole management and direction, of illiterate and incompetent judges. Sure I am, had we ſuch an appointment amongſt us, as that of *Cenſor Tabularum*, all Mr. Ferguſon's Solar and Lunar Tables, without exception, would have long ago been interdicted, as unfit for common uſe. Pages might be filled with examples of his extremely erroneous calculations in the remote ages; and it would be but a piece of juſtice due to the public, to eſtimate thoſe errors.

Should the particular reſults of Mr. Ferguſon's calculations of this eclipſed full moon, with thoſe of mine, be ſet down in two oppoſite columns, there would appear ſuch a wide diſagreement between them, that no one would be inclined to think, that we could poſſibly have had one and the ſame object in view. But as theſe wide diſagreements may poſſibly gratify the curioſity of ſome, I ſhall repreſent them, in the annexed Table, as diſtinctly and as fully as I can.

An Eclipſe of the Moon was obſerved at Alexandria, under the following circumſtances.

According to Ferguson's Tables and Computations.	According to Kennedy's Tables and Computations.
0. ——— ——— ———	1. In the end of the 4th year of the reign of Ptolemy Epiphanes, king of Egypt.
1. In the Julian year 201, A. C.	2. In the 54th year of the 2d period of Calippus, concurrent with the 547th year from Nabonaſſar.
2. In the year of the Julian period, 4513.	3. In the appropriated year of the world, 3807.
3. The ſun's place, at the time of that eclipſe, was towards the beginning of the 27th° of Virgo.	4. The ſun's place, at the time of that eclipſe, was towards the beginning of the 29th° of Virgo.
4. Within 4 days before the autumnal equinox.	5. Within 2 days before the autumnal equinox.
5. The mean time of full moon at Alexandria, was, by calculation, Sept. 22d. 19h. 44′ 48″ p. m.	6. The mean time of full moon at Alexandria, was, by calculation, Meſori 16d. 5h. 2′ 20″ 30‴ p. m.
6. The ſum of the lunar equations to be ſubtracted, by the Tables of the moon's mean anomalies, was, 12h. 18′ 20″	7. The difference between the mean time of that eclipſed full moon and the true, to be added, was, 1h. 57′ 39″ 30‴
7. Day of the week, Friday.	8. Day of the week, Sunday.
8. The Julian month and day of the autumnal equinox, was, by calculation, Sept. 26.	9. The Egyptian month, day, hour, and minute, of the autumnal equinox, at Alexandria, was, by calculation, Meſori 18d. 4h. 28m. p. m.
9. Day of the week, Tueſday.	10. Day of the week, Tueſday.

By comparing the contents of theſe two columns together, we immediately perceive an irreconcileable difference in the times.

Here I think it neceſſary to make my appeal to our Aſtronomer Royal, as to an authorized judge.

> "Nec Deus interſit niſi dignus vindice nodus
> "Inciderit."——

My requeſt is, that I may be indulged the liberty, without offence, to propoſe the ſeveral Queries enſuing; hoping that our Learned Profeſſor will not think it either beneath the dignity of his ſtation, or at all foreign to his office, to lend a helping hand towards the ſolution of them.

Query I. What is the exact difference of the times between theſe two tabular calculations?

Query II. What is the ſum of the error? for a groſs and palpable error there undeniably is, and muſt be in one of the calculations; and the aſtronomical critic will determine on which ſide it lies.

Query III. How may this ſum of the error be analyſed into its ſeveral diſtinct parts?

Query IV. From what particular cauſes does the error of the ſeveral diſtinct parts ariſe?

Query V. How may they be reſpectively corrected to a mathematical exactneſs?

Query VI. What is the preciſe definition, 1ſt, of a ſolar tropical year? 2dly, of a mean lunation or ſynodical month? 3dly, of a ſolar day? &c. &c.

It is too notorious to be concealed, and too evident to be denied, that the Aſtronomers, to this day, are not agreed among themſelves concerning the *ακρίβεια* of tabular meaſures.

And therefore the moſt important Query of all muſt be, By what means may this indiſpenſible accuracy be aſcertained and proved? For until it be aſcertained and proved, Solar and Lunar Tables can claim on higher a title than that of—*ſpecioſæ nugæ.*

It might eaſily be evinced, that the contents of theſe Queries are ſo far from being the dreams of a deluded fancy, that they will moſt ſurely be found, when duly conſidered, to be of ſufficient importance, to engage the attention of a Profeſſor: nor do I ſee, indeed, how they can poſſibly fail to engage it, as ſo much depends on the right underſtanding, and explanation of them.

JOHN KENNEDY.

GR III
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To the Rev. Dr. BLAIR.

LETTER I.

REVEREND SIR,

FULL eighteen years have elapſed, ſince the publication of your Chronological Tables; engraven with ſo much beauty, elegance and coſt. The examination of them gave me an accumulated pleaſure, upon the account of the great variety of hiſtorical occurrences—remarkable events—memorable battles—the riſe and fall of empires—aſtronomical obſervations—the times in which a multitude of perſons flouriſhed, famous in their reſpective generations, men of renown. The extenſiveneſs of your plan, as you have framed it; the uniting and bringing into one point of view the ſeveral cotemporary ſtates and kingdoms; your tables conſiſting of fifty lines each, with their unuſual mode of conſtruction—are truly admirable. And they muſt, undeniably, have been univerſally eſteemed as ſuch, had it been poſſible to have executed them according to your ingenious and well-intended deſign—amidſt ſuch innumerable uncertainties. But as you have unluckily built upon Arch-Biſhop Uſher's defective ſyſtem, which you adopted, you ſay, not becauſe you thought it demonſtrably true, but becauſe it is the moſt generally received; it is impoſſible you ſhould have one parallel line replete with true aſtronomical ſynchroniſms, whilſt a year of the artificial Julian period ſtands in the front, which cannot be obtained, but *ex hypotheſi*, by a computation backwards from a given year.

As I have employed ſome pains and time upon this intricate and much agitated ſubject, I am emboldened to give it as my opinion, that the grand *deſideratum*, and moſt eſſential requiſite, in a general ſyſtem of chronology, is a true aſtronomical receptacle of all intermediate æras and epochs from the æra of the creation, through an uninterrupted ſeries of Julian and ſolar tropical years, (which are included in them) down to that which is current.

Juſt ſuch a receptacle as I am now ſpeaking of, not long ſince, very luckily occurred: It owes its riſe to a ſudden thought, which I immediately purſued, and found it to anſwer, uniformly, the utmoſt extent of my wiſhes; I cannot ſay my expectations, for it far exceeds them. The whole of the ſecret conſiſts in nothing more than a ſimple change (upon a fixt principle, and by an invariable law) in the poſition of the years of the vulgar Julian period. By this ſimple change, the cycle of the ſun, and the cycle of the moon, are thereby rendered aſtronomically true, when applied to any given year, in any given interval, without being liable to error. This, you muſt allow, is a very extraordinary effect; and perhaps this very intimation of it may excite in you both the curioſity, and the inclination, to be better acquainted with it.

My preſent deſign is, to evince, by an example, that the correſponding year of the aſtronomical Julian period is not only uſeful, but quite neceſſary to be known, in the calculation of Ptolemy's eclipſes, upon Ptolemy's *data*.

I ſhall take for an example the moſt ancient eclipſe of the moon upon record. Almeg. l. iv. c. 6.

As this diſtinguiſhed and moſt remarkable eclipſe is characterized with a more minute detail of particulars than any other throughout Ptolemy's great work, I ſhall here enumerate them.

1ſt. Ptolemy repreſents it, from the writings of Hipparchus, as the firſt of the three ancient eclipſes which were obſerved at Babylon.

2d. It happened, he ſays, in the firſt year of the reign of Mordac Empadus.

3d. In the 27th year from Nabonaſſar.

4th. In the Egyptian month Thoth, on the 29th day of the month, which was followed by the 30th.

5th. It began an hour after the moon was riſen.

6th. It was total.

7th. The ſun being then towards the latter end of Piſces, and the night 12 equinoctial hours long nearly, it began 4 ½ hours before midnight; i. e. at 7h. 30m p. m. conſequently, the moon roſe at 6h. 30m. p. m.

8th. The middle time at Alexandria was 3 ⅓ hours before midnight; i. e. at 8h. 40m. p. m.

9th. The middle time at Babylon was 2 ½ hours before midnight; i. e. at 9h. 30m. p. m.

10th. The meridian which paſſes over Alexandria, lies half an hour, and one third of an hour, i. e. fifty minutes of time weſtward of that meridian which paſſes over Babylon.

From this detail I ſhall take the following *data* for the baſis of the ſubſequent calculations.

A total eclipſe of the moon was obſerved at Babylon.

1ſt. In the 27th year from Nabonaſſar.

2d. At that full moon which came next before the vernal equinox in that year. This is inferred from the ſun's being towards the latter end of Piſces.

3d. The middle time at Alexandria was at 8h. 40m. p. m.

4th. The middle time at Babylon, at 9h. 30m. p. m.

Theſe points being ſtated, let the firſt article of enquiry be, in what Egyptian month, on what day of the month, at what hour and minute, did the ſun come to the vernal equinox, at Alexandria, in the year from Nabonaſſar 27?

In order to facilitate the calculation required, I ſhall ſubjoin

A Table of the times of the Sun's entry into the four cardinal points of the Ecliptic, in the months and days of the Egyptian year, for the four firſt years of the reign of Nabonaſſar, calculated for the Meridian of Alexandria, to which if we add 50′, it will give the time at Babylon, as computed by Ptolemy.

Yrs of a Quadriennium.	Yrs of the Aſtronomical Jul. Period.	☉ in ♈ Month Thoth.			☉ in ♋ Month Tybs.			☉ in ♎ Month Pharmuths.			☉ in ♑ Month Epiphi.			
		D.	H.	M.	D.	H.	M.	D.	H.	M.	D.	H.	M.	
0	3260	-	-	-	-	-	-	-	-	-	5	6	42	p.m.
1	3261	29	8	43	2	7	25	5	20	34	5	12	31	
2	3262	29	14	32	2	13	14	6	2	23	5	18	20	
3	3263	29	20	21	2	19	3	6	8	12	6	0	9	
0	3264	30	2	10	3	0	52	6	14	1	6	5	58	

By the help of this Table, the days of the Egyptian month, on which the ſun entered any of the four cardinal points, and on which the new moons and full moons happened, either next before, or next after, an equinox or a ſolſtice, may be eaſily calculated, (by the help of the epact, as we ſhall ſee by and by) in any given year from Nabonaſſar.

The CALCULATION.

Divide the year from Nabonaſſar 27 by 4, and the quotient will give 6d. 18h. for the retroceſſions of Thoth, which we muſt call ſeven days. (*a*)

(*a*) Here it will be neceſſary to make the following remark: If a given year from Nabonaſſar, after the diviſion by 4, leaves in remainder 3, which ever denotes a Julian biſſextile year; and if, in the correſponding Julian year, the firſt of Thoth falls between the kalends of January, and the 29th of February, as in the preſent example; I find, by making the trial, that without completing the odd 18h. into a day, I cannot calculate the day of the Egyptian month, on which the eclipſed full moon happened, in agreement with Ptolemy's record, although I muſt leave it to others to diſcover and explain the reaſons of it.

Look into the index prefixed to the table for the number 3 (the remainder after the diviſion of 27 by 4) and in the ſame parallel line, under ☉ in ♈, will be found theſe times——Thoth 29d. 20h. 21m. p. m.

To 29d. add 7, for the retroceſſions of Thoth; then from the ſum 36 ſubtract the 30 days of Thoth, and there will remain Paophi 6d. for the day of the vernal equinox, an. ær. Nabonaſſ. 27.

But in order to find the hour and minute, we muſt remember, that the ſun enters the cardinal points 11 minutes earlier every year; therefore from 27 years ſubtract 3; then multiplying the remainder 24 into 11 minutes, it will give 4h. 24m. for the retroceſſions of the equinox in that time.

To Paophi 6d. add from the table (No. 3.) 20h. 21m. p. m. then we ſhall have Paophi 6d. 20h. 21m. p. m; from which ſubtract 4h. 24m. for the retroceſſions of the equinox, and it will leave Paophi 6d. 15h. 57m. p. m. for the time of the equinox at Alexandria, an. ær. Nabonaſſ. 27.

The truth of theſe calculations, with reſpect to the meridian of Alexandria, will clearly appear in the lunar computation.

LETTER II.

HAVING aſcertained the Egyptian month, day, hour and minute, on which the ſun came to the vernal equinox at Alexandria, in the year from Nabonaſſar 27; I muſt, in the next place, calculate the Egyptian month, day, hour and minute, on which the eclipſed full moon happened, next before that cardinal point, in the ſame year, and in the ſame meridian.

But as, in theſe calculations, I ſhall have occaſion to make uſe of the correſponding year of the aſtronomical Julian period; it may be neceſſary, firſt, to ſhew how eaſily the artificial Julian period may be converted into an aſtronomical one; I mean, with reſpect to the cycle of the ſun, and the cycle of the moon: the indiction, being a civil character, can ſerve no other purpoſe, but to make up the number, by a joint multiplication, of 7980 years.

I look into your Chronological Tables for the Plate No. 6; and for that parallel line, where in the oppoſite page you have noted this very eclipſe as having happened on the 19th of March; i. e. you have ſet it down in the Julian ſtyle inſtead of the Egyptian: whereas the Julian ſtyle never occurs in the Almegiſt, as far as I could obſerve in my examination of it; and I have made ſeveral extracts from it. The reduction to the Julian ſtyle is an *after* conſideration; and it muſt, unqueſtionably, be thought ſo, as it is never made uſe of by Ptolemy in his aſtronomical computations; although, as he flouriſhed about the middle of the ſecond century of chriſtianity, we cannot ſuppoſe him to be unacquainted with it.

In the front of this parallel line ſtands the year of the Julian period 3993, whilſt the true year of the world lies concealed under its artificial cover, without any certain directions how to develop it. The unlimited range of hypotheſis, to uſe your own expreſſion, ſeems to have diſcouraged you from the attempt; but it needed not: for the 300 different opinions concerning the year of the creation, as mentioned in your preface, may be eaſily reduced to 3; and thoſe 3, by a ſingle calculation, to the only true one—with a demonſtrable certainty. So far is it from my intentions to amuſe the intelligent reader—*with the mere play of a prolific imagination.*

But to return to the point in hand, divide 3993 by 28, 19 and 15; and it will leave in remainder 17 for the cycle of the ſun, 3 for the cycle of the moon, and 3 for the indiction.

The ſtandard and invariable numbers to be ſubſtracted, whatever year of the Julian period may be given, are 6, 3, 1. *E. g.*

From 17 ſubtract 6, and it will leave in remainder 11, for the cycle of the ſun; from 3 ſubtract 3, and it will leave in remainder 0, i. e. 19, for the cycle of the moon; from 3 ſubtract 1, and it will leave in remainder 2 for the indiction.

				Products.
Multiply	11, the cycle of the Sun,	into	4845	53295
	19, the cycle of the Moon,		4200	79800
	2, the indiction,		6916	13832
		The Sum		146927

Divide the ſum of theſe 3 products by 7980, and it will leave in the remainder 3287, for the correſponding year of the aſtronomical Julian period; which being divided by 28, will give 11 for the cycle of the ſun; and being divided by 19, will give 0, i. e, 19, for the cycle of the moon . the advantage of theſe cycles 11 and 19, will appear, when the day of the week, and the epact, are required.

Theſe 3287 years are computed to begin and end at the autumnal equinox; and they may be reckoned, either as Julian or as ſolar tropical years, as the ſubject matter may require. But it will ſoon be determined, in the preſent caſe, upon the account of the reduction of years to days, that they muſt be taken for ſolar tropical years, each conſiſting of 365d. 5h. 49m. therefore, from 3287 years ſubtract 6 months, and it will carry it back from the autumnal to the vernal equinox. And now the meaſure of the interval will be 3286 ſolar tropical years, and 6 months.

We are to determine the mean diſtance of full moon next before this vernal equinox.

The CALCULATION.

If we divide 3286 years by 19, the quotient will give 172 entire cycles, leaving in the remainder 18 years of another cycle. This calculated remainder 18, is what we vulgarly call the Golden Number; and, as we ſhall ſee by and by, will lead us to a diſcovery of the appropriated epact.

The Epact, as it is technically called, is the adequate meaſure of the diſtance between the moment of an equinox, or a ſolſtice, and the moment of that mean new moon, or full moon, which comes next before it: and it is either Integral, conſiſting of entire days; or Aſtronomical, conſiſting of days, hours, and minutes, &c.

The Integral epact, being ſubtracted from the day of an equinox, or a ſolſtice, will carry it back to the day of full moon, or new moon, which comes next before it.

The aſtronomical epact, being ſubtracted from the moment of an equinox, or a ſolſtice, will carry it back to the moment of mean new or full moon, in the ſame meridian.

The aſtronomical epact may be juſtly called an appropriated character, becauſe it cannot return, under the ſame identical quantity, through the whole extent of 7980 years, which are more than have paſſed ſince the creation.

I ſhall firſt calculate the Integral, and then the Aſtronomical epact. But theſe will require the aſſiſtance of the ſubjoined tables.

TABLE. I.

Exhibiting 19 vernal-equinoctial full-moon epacts for the firſt 19 years of the aſtronomical Julian period.

Golden Numbers.			D.	H.	′	″	‴
1	-	-	12	10	34	28	30
2	-	-	23	7	35	7	30
3	-	-	4	15	51	44	45
4	-	-	15	12	52	23	45
5	-	-	29	9	53	2	45
6	-	-	7	18	9	40	00
7	-	-	18	15	10	19	00

Golden Numbers.	Table I. continued.				
8	29	12	10	58	00
9	10	20	27	35	15
10	21	17	28	14	15
11	3	1	44	51	30
12	13	22	45	30	30
13	24	19	46	9	30
14	6	4	2	46	45
15	17	1	3	25	45
16	27	22	4	4	45
17	9	6	20	42	00
18	20	3	21	21	00
19	1	11	37	58	15

TABLE II.

Exhibiting a ſeries of Cyclic Numbers, calculated for 300 decennoval cycles. Vid. Syſt. of Chronol. p. 215.

Cycles.	D.	H.	′	″	‴
1	0	1	55	51	15
2	0	3	51	42	30
3	0	5	47	33	45
4	0	7	43	25	00
5	0	9	39	16	15
6	0	11	35	7	30
7	0	13	30	58	45
8	0	15	26	50	00
9	0	17	22	41	15
10	0	19	18	32	30
20	1	14	37	5	00
30	2	9	55	37	30
40	3	5	14	10	00
50	4	0	32	42	30
60	4	19	51	15	00
70	5	15	9	47	30
80	6	10	28	20	00
90	7	5	46	22	30
100	8	1	5	25	00
200	16	2	10	50	00
300	24	3	16	15	00

LETTER III.

THE practical uſe and application of theſe tables of epacts and cyclic numbers, will be fully illuſtrated in the preſent example.

It appears, from what has been ſaid above, that if we divide 3286 years by 19, the quotient will give 172 entire cycles, leaving in the remainder 18 years of another cycle.

Look for this remainder 18 in the column of Golden Numbers, prefixed to Table I. and it will be found in the ſame parallel line with this vernal-equinoctial full-moon epact——20d. 3h. 21′ 21″ 00‴.

Here let it be obſerved, that although the golden number is 18, the calculated cycle of the moon is 19; for the cycle of the moon is ever 1 year forwarder than the golden number expreſſes, excepting at the autumnal equinox, when they are coincident.

The numbers in Table II. anſwering to 172 entire cycles, when collected into a ſum, are, 13d. 20h. 6′ 55″ 00‴, from which throw off 1 day (for reaſons to be explained hereafter) and there will remain 12d. 20h. 6′ 55″ 00‴.

From 20d. 3h.—— (Table I. No. 18.) ſubtract 12d. 20h.——for 172 entire cycles; then rejecting the odd hours, there will remain 7 days, for the integral full-moon epact ſought.

To Paophi 6, the calculated day of the vernal equinox, add the 30 days of Thoth; then from the ſum 36 ſubtract the integral full-moon epact 7, and it will carry it back to the 29th of Thoth, in agreement with Ptolemy's record.

Query I. Whether the Egyptian month, and day of the month, on the evening of which Ptolemy's eclipſes are ſaid to have been obſerved, were ever calculated, or ſo much as attempted, by the tables in common uſe?

Query II. Whether they can be calculated without the help of the epact? In my opinion they cannot, and ſhould be glad to ſee the opinion refuted. Permit me to ſay, you would highly merit the thanks of thoſe, whom it may more immediately concern, if you would undertake, publicly, to refute the opinion: and as you are a good proficient in aſtronomy, it would be no degrading condeſcenſion.

A Calculation of the Aſtronomical Epact.

From the vernal-equinoctial full-moon epact 20d. 3h. 21′ 21″ 00‴ (Table I. No.18.) ſubtract for 172 entire cycles, having thrown off 1 day, 12d. 20h. 6′ 55″ 00‴, and it will leave in remainder 7d. 7h. 14′ 26″ for the mean aſtronomical full-moon epact ſought.

To Paophi 6d. 15h. 57m. p. m. the calculated time of the vernal equinox at Alexandria, an. ær. Nabonaſſ. 27, add the 30 days of Thoth; then from the ſum 36d. 15h. 57m. p. m. ſubtract the mean aſtronomical full moon epact, 7d. 7h. 14′ 26″, and it will carry it back to Thoth 29d. 8h 42′ 34″, for the mean time of full moon, in the ſame meridian. Subtract 2′ 34″, for the difference between the mean time of that eclipſed full moon, and the true; there will remain Thoth 29d. 8h. 40m. p. m. in exact agreement with the recorded middle time at Alexandria; to which if we add 50′, it will give 9h. 30m. p. m. for the recorded middle time at Babylon.

If you, or any other practical aſtronomer, ſhould have a deſire to be rightly informed of the preſent ſtate and condition of the tables in common uſe, you need only calculate this moſt ancient lunar eclipſe, in the Egyptian ſtyle, upon Ptolemy's data.

Ptolemy explicitly affirms that this eclipſe was total. Might it not have been central too? and if it really happened, either at an apogeal or perigeal full moon, (the ſmallneſs of the difference between the mean time and the true, countenancing the ſuppoſition, that the moon was at that time pretty near to one of the extreme points of her orbit) can a more proper teſt be made choice of, by which to try the truth of tabular mean meaſures, or to eſtimate their error?

LETTER IV.

TO ſupport and confirm the truth of the preceding calculations, I propoſe, in this, to bring the Egyptian form of year down to the 18th century of Chriſtianity, which is now current; and, more particularly, to that mean full moon, which will come the next but one after the vernal equinox A. D. 1780; then taking it for a radix to calculate backwards from thence through 25 complete centuries.

But, as the neceſſary operations will be unavoidably many, it may be expedient to regiſter them in the margin, and keep them diſtinct from each other by numbering them.

1. To the year from Nabonaſſar 27, add 2500 years, and the ſum will be the 2527th Julian year from Nabonaſſar, brought down to the preſent times.

2. From the year of the aſtronomical Julian period 3287, ſubtract the year from Nabonaſſar 27, and it will carry it back to the year of the aſtronomical Julian period 3260 (which immediately preceded the year in which the æra of Nabonaſſar commenced) to which add 2527 and the ſum 5787 will be the year of the aſtronomical Julian period, correſponding with the 2527th Julian year from Nabonaſſar.

3. Divide the year of the artificial Julian period 4713, which anſwers to the year of Chriſt's birth 0, ær. vulg. by 28, 19, 15; and it will give 9 for the cycle of the ſun, 1 for the cycle of the moon, and 3 for the indiction. From theſe ſubtract the invariable numbers, 6, 3, 1; and we ſhall have 3 for the cycle of the ſun, 17 for the cycle of the moon, and 2 for the indiction.

4. Multiply theſe 3 laſt cycles, 3, 17, 2, into the ſtandard numbers, 4845 4200. 6916, then dividing the ſum of the 3 products by 7980, the remainder will give 4007 for the correſponding year of the aſtronomical Julian period.

5. From the year of the aſtronomical Julian period

5787, ſubtract 4007, and the remainder will give A. D. 1780; nor can the year 5787 be aſtronomically connected with any other year of our Lord, upon the account of the appropriated epact.

6. Divide the year from Nabonaſſar 2527 by 4, and the quotient will give 631 d. 18 h. for the retroceſſions of Thoth, which we may call 632 days.

7. Becauſe 2527 years include a Sothiac period, conſiſting of 1460 Julian years, in the end of which Thoth returns to its original ſtation, from 632 d. ſubtract 365, the number of days in 1 year, the remainder 267 will be the retroceſſions of Thoth.

8. Look into the column prefixed to the Table of Equinoxes and Solſtices (p. 4) for the number 3; the remainder, after the diviſion of 2527 by 4, and in the ſame parallel line, under ⊙ in ♈, we ſhall find, as in a preceding calculation, theſe times— Thoth 29 d. 20 h. 21 m. p. m. which being added to 267, the ſum will be 296 d. 20h. 21 m. p. m.

9. To find in what month, and on what day of the month, the laſt of theſe 296 days will fall, diſtribute them into the months of the Egyptian year, reckoning 30 days to a month; it will appear that the 296th day will terminate on the 26th day of Pauni, the 10th month of the Egyptian year.

10. But becauſe the ſun enters the cardinal points, as it has been already obſerved, 11 minutes earlier every year, from 2527 years ſubtract 3; then multiplying the remainder 2524 into 11, the product will give 19 d. 6 h. 44 m. for the retroceſſions of the equinox in that interval. Therefore,

11. From 296 d. 20 h. 21 m. p. m. ſubtract 19 d. 6 h. 44 m. and it will carry it back to the 7th of Pauni, à kalend. Thoth 277 d. 13 h. 37′ p. m. for the time of the vernal equinox at Alexandria, an. ær. Nabonaſſ. 2528.

12. Required the vernal-equinoctial full-moon epact,

in the year of the aſtronomical Julian period 5787, A. D. 1780.

From 5787 years ſubtract 6 months, and it will carry it back from the autumnal to the vernal equinox, leaving in remainder 5786 ſolar tropical years, and 6 months.

13. Divide 5786 years by 19, and the quotient will give 304 entire cycles, leaving in the remainder 10 years of another cycle. Look into the column of Golden Numbers (Table I. p. 9.) for the number 10, and it will direct us to this epact 21 d. 17 h. 28′ 14″ 15‴. to which add 1 lunation to make the ſubtraction, and the ſum will be—51 d. 6 h. 12′ 16″ 00‴.

14. The numbers in Table II. anſwering to 304 entire cycles, when collected into a ſum will be—24 d. 10 h. 59′ 40″. From 24 days throw off 2 (for reaſons to be explained hereafter) and there will remain 22 d. 10 h. 59′ 40″.

15 From 51 d. 6 h. 12′ 16″, ſubtract for 304 entire cycles 22 d. 10 h. 59′ 40″, and the remainder will give 28 d. 19 h. 12′ 36″ for the mean aſtronomical full-moon epact, at the vernal equinox, in the year 5787, A D. 1780.

16. From Pauni 7 d à kalend. Thoth, 277 d. 13 h. 37 m. the calculated time of the vernal equinox, ſubtract the mean aſtronomical full-moon epact, 28 d. 19 h. 12′ 36″, and it will carry it back to Pachon (the 9th month of the Egyptian year) 8 d. à kalend. Thoth 248 d. 18 h. 24′ 24″ p. m. for the mean time of full moon next before the vernal equinox, an. ær. Nabonaſſ. 2528.

17. To Pachon 8 d à kalend Thoth 248 d. 18 h. 24′ 24″ p. m. add 1 lunation, and it will bring it down to Pauni 8 d à kalend. Thoth 278 d. 7 h. 8′ 25″ 45‴ p. m. for the mean time of full moon next after the vernal equinox, an. ær. Nabonaſſ. 2528.

18. To Pauni 8 d. à kalend. Thoth 278 d 7 h. 8′ 25″ 45‴, add 1 lunation, and it will bring it down

to Epiphi 7 d. à kalend. Thoth 307 d. 19. 52′ 27″ 30‴ for the mean time of full moon, the next but one after the vernal equinox, an. ær. Nabonaſſ. 2528.

19. From 2500 years ſubtract, for a Sothiac period, 1460, and it will leave in remainder 1040 years, which being divided by 4 will leave in remainder 260d. for the retroceſſions of Thoth in that interval.

20. From Epiphi 7 d. à kalend. Thoth 307 d. 19 h. 52′ 27″ 30‴ ſubtract 260 for biſſextile days, and it will carry it back to Paophi 17 d. à kal. Thoth 47 d. 19 h. 52′ 27″ 30‴. This I call the Julian ſtation of the moon, every year being now ſuppoſed to conſiſt of 365 d. 6 h.

21. 2500 years include 30922 lunations, which give, by reduction,

	D.	H.	′	″		‴
	913144	11	9	52	27	30
Subtract for 2500 Julian years	913125					
Remainder to be ſubt.	19	11	9	52	27	30

	D.	H.	′	″	‴
22. From Paophi 17 d. à kal. Thoth	47	19	52	27	30
Subtract for 2500 years, having first thrown off 1 day	18	11	9	53	30
Remains, as above, Thoth	29	8	42	34	00

23. Subtract 2′ 34″, for the difference between the mean time of that eclipſed full moon and the true, it will leave in remainder, Thoth 29 d. 8 h. 40 m. p. m. for the recorded middle time, at Alexandria.

Here I am prompted to make one obſervation. This identity of the mean time of an eclipſed full moon nearly in coincidence with the recorded middle time, obtained, Firſt, by a calculation downwards from the original radix to the given year, through a ſeries of 3286 ſolar tropical years, and 6 months; Secondly, by a calculation backwards from a calculated radix, through 25 complete centuries, offers itſelf as an unexceptionable teſt, by which to try the truth of tabular mean meaſures, or to eſtimate their error.

I appeal to the ingenious Dr. Blair's judgement, whether this obſervation be not juſt.

LETTER V.

HAVING finiſhed the propoſed calculations, in bringing the Egyptian ſtyle down to the preſent times; (and may I not venture to ſay, that ſuch calculations were never attempted before by any one? at leaſt, that I know of, having never ſeen an example of it) it may perhaps be expected that I ſhould make the ſame calculations in the months and days of the Julian year, correſponding aſtronomically with the months and days of the Egyptian year, aſſigned by Ptolemy in his Almegiſt. And, indeed, it might well be thought a matter of ſome credit, to undertake and ſucceed in a reduction, that has never yet been rightly performed.

This hint may poſſibly raiſe your attention to a remark which I met with in one of Ricciolus's epiſtles, dated 1634, and inſcribed, I think, *Keplero*. There appeared to me ſomething ſo very particular in it, that I thought it worth my while to make a memorandum of it. It is as follows.

—"Aut igitur Ptolemæi obſervationes inſigniter "oberrant, aut dies anni Dionyſiani non omnes omnino "competunt, ad dies anni Egyptiaci aſſignatos a Pto"lemæo."——

This was laid by, as a neglected memorandum, for ſome years; until, at length, I found there was a great deal more meaning in it, than I at firſt apprehended; and I am pretty confident that ſo will you.

It may be juſtly thought, that a more perplexing difficulty cannot occur, nor a harder taſk be impoſed, in the whole compaſs of practical aſtronomy, than a true aſtronomical reduction of the Julian ſtyle to the Egyptian, and *vice verſa*: no one example can be given of it, although many have attempted it.

It has been already obſerved, that in your Chronological Tables, Plate 6. you have tranſmitted down this very eclipſe, as having been obſerved in the evening of the 19th of March. I fell into the ſame error myſelf, as may be ſeen in my Syſtem of Chronology, p. 270, at the bottom; but having ſince had the means of better information, I can now upon good grounds aver, that if the Julian ſtyle be extended backwards to the 27th year from Nabonaſſar, no full moon can be found, by any true calculation, on the evening of the 19th of March, in any one meridian of the globe; no, nor in the evening of the 20th of March, at Alexandria, before more than half an hour paſt eight o'clock at night. You have therefore really tabled an eclipſe a whole day, at leaſt, before the moon was in oppoſition to the ſun.

I durſt undertake to prove, that more than one ancient tabular eclipſe has been announced, near two days before there was any full moon in the heavens; and an *imaginary acceleration* of the moon's mean motion has been deduced from it.

Of what uſe, I may aſk, can equations be in ſuch a caſe?

Had Ptolemy recorded the day of the week, together with the Egyptian month, and day of the month, on which his eclipſes are ſaid to have been obſerved, that which may now, perhaps, be ſlightly paſſed over, as a mere fanciful dogma, under that ſingle circumſtance, would have been univerſally credited and admitted, without the leaſt doubt or heſitation.

I ſhall now proceed to lay open and explain the true grounds and reaſons of this unapprehended and unſuſpected difficulty, in

LETTER VI.

IN the Preface to your Chronological Tables, you have given an intimation, to your ſubſcribers, of your intentions to publiſh Three Diſſertations, upon ſuch very important points, as were to me a ſufficient indication both of your knowledge and your judgement.

The ſubject of one of your propoſed diſſertations was, An Examination of the Authorities upon which Æras are founded.

Let us take, for an inſtance, the æra of Nabonaſſar; and let the article of enquiry be, upon what authority the Julian ſtation of this æra was fixed, ſo many centuries ago, to the 26th of Feb. It is certain that Cenſorinus adopted it, who wrote his book *de Natali Die*, as far back as towards the beginning of A. D. 238. So you have computed it in your Tables, A. J. P. 3967. And in defence of it, you can alledge many, very many authorities, both ancient and modern; you can refer, without any derogation to your judgement, to Arch-Biſhop Uſher's Annals, p. 50. where he writes as follows.

"A meridie primi diei Thoth, menſis Ægyptiaci, "die videlicet Februarii 26, Nabonaſari epocham "ſummo conſenſu deducunt omnes aſtronomi."

Now who dares be ſo raſh, as to controvert a deduction ſo unanimouſly authenticated by the whole body of aſtronomers?

However, let it be ſuppoſed, if you pleaſe, that no ſuch deduction had ever been made, and that this was the firſt attempt towards it: and if I alſo can alledge ſufficient authorities to juſtify a deviation from the long-beaten track, ſhould they chance to fail of conviction, they may, at leaſt, cauſe a ſuſpenſion of judgement, and prove the means of promoting a further enquiry.

Before I enter upon this diſquiſition, it may be neceſſary to premiſe a few particulars concerning the æra of Nabonaſſar in general.

The celebrated æra of Nabonaſſar (and therefore celebrated, becauſe made uſe of by Ptolemy, from which to calculate his eclipſes, and other celeſtial phænomena aſtronomically) in itſelf conſidered, is quite unaſtronomical; for it neither commenced at an equinox, nor at a ſolſtice, nor at a new moon, nor at a full moon, but on ſome intermediate day between the winter ſolſtice A. J. P. 3966, and the vernal equinox A. J. P. 3967. Thus far we are certain. But the actual determination of this intermediate day, entirely depends, not upon the calculations of aſtronomy, but the evidence of authentic hiſtory: ſuch evidence every reader has a right to demand, and it lies upon me to produce it.

Arch-Biſhop Uſher, Annal. Mundi, p. 577. A. J. P. 4684, has inſerted a paragraph, part of which I ſhall here tranſcribe.

" Cœpit igitur epocha Auguſtorum Ægyptiaca die
" primo menſis Thoth, ineuntis anni Nabonaſari 719.
" menſis nimirum Sextilis (Auguſti Juliani) die 31,
" qui juxtà *vitioſam intercalandi rationem* Romæ tunc
" uſurpatam, Sextilis 29 *dies dicebatur*.

What the Arch-Biſhop has but juſt hinted at here in a few words, Dr. Prideaux has deſcanted upon in a minute and circumſtantial manner, as may be ſeen in the following extract, which being but an abridgment, I ſhall refer, for the whole, to his Hiſtorical Connection of the Old and New Teſtament, Part II. L. VIII. p. 590, 591. Octav. Edit.

——" The firſt of Thoth, falling on the 29th
" of Auguſt, they fixed the beginning of the new
" reformed year, where they found the beginning of
" the old; and the 29th of Auguſt ever after conti-
" nued to be the firſt day of the Egyptian year, as long
" as the empire of the Romans continued in that
" country.

—— "But againſt this it is objected, that in this "year the firſt of Thoth did not fall on the 29th of "Auguſt, but on the 31ſt of that month.——"And it "muſt be acknowledged, that *according to the exact* "*calculation of the time*, this objection is true; for, "*according to that*, the firſt of Thoth fell this year, "in the Roman Kalendar, *on the 31ſt*, and *not on the* "*29th* of Auguſt. But the Romans then uſed the form "of the Julian year *erroneouſly*; whereby it came to "paſs, that the ſame day, which was their 31ſt in the "True Kalendar, was the 29th in their Erroneous Kalen-"dar.——"A *miſtaken intercalation* had protruded the "29th of Auguſt in their erroneous kalendar, into the "place of the 31ſt of Auguſt in their true kalendar; "and according to this erroneous kalendar the Romans "then computed.——"But the protruſion of the day, "making no alteration in the number or the name, *hence* "*it came to be ſaid*, that it was the 29th of Auguſt; "whereas truly it was the 31ſt."

The true ſtate of the caſe, in ſhort, is this. Julius Cæſar, when he inſtituted his fixed ſolar year of 365 d. 6 h. ordered a day to be intercalated, in the end of every fourth, and in the beginning of every fifth year, which Ovid thus expreſſes.

——— "ad Luſtrum accedere debet,
"Qui conſummatur partibus, una dies."

But the bungling Pontifices, to whom the care and management of intercalation was committed, either through ignorance, or inadvertency, or both, made every third year to be Leap year, inſtead of every fourth; by which error 6 hours were added every third year, more than ſhould be.

The firſt fixed Egyptian ſolar year comenced an. ær. Nabonaſſ. 724. in the fifth year of the reign of Auguſtus, reckoned from the conqueſt of Egypt, and in the 21ſt Julian year.

Divide 21 years by 3, and the quotient will ſhew, that the ignorant Pontifices had made 7 intercalations, when they ſhould have made but 5. Multiply 6 hours into 7, and the product will give 42 hours, i. e. 1d. 18h. for the ſum of the error ariſing from a miſtaken intercalation, in the ſpace of 21 years.

To Aug. 29, 6 h. p. m. in the erroneous Roman kalendar, add 1d. 18h. and it will carry it forward to Aug. 31, 0 h. 0 m. i. e. noon, in the true Roman kalendar.

To Aug. 31, à kal. Jan. 243 d. add 181 days, for the retroceſſions of Thoth in 724 Nabonaſſarean years; then from the ſum 424, ſubtract 365, and it will bring it down to the 59th day à kal. Jan. from 59 d. ſubtract the 31 days of January, and it will leave in remainder February the 28th, for the true Julian epoch of the firſt Nabonaſſarean year.

The twofold epoch may be thus repreſented to the view.

The æra of Nabonaſſar commenced,
On Feb. 26, in the erroneous Roman kalendar.
On Feb. 28, in the true Roman kalendar.

Should we have occaſion to reduce the Julian ſtyle to an agreement with the Egyptian, we muſt compute from Feb. 28, in the true Roman kalendar, and not from Feb. 26, in the erroneous one.

The indiſpenſible neceſſity of this computation may be proved by juſt as many arguments, as Ptolemy has recorded eclipſes, and other celeſtial phænomena, in his Almegiſt.

Your remarks upon this deduction, and the joint teſtimonies which directed me to make it, may ſooner or later be of ſervice to the public.

I claim not to myſelf the merit of making this diſcovery, which was well known ſome centuries ago: I only claim the merit of pointing out the neceſſity of its practical application.

LETTER VII.

THE principal motive for writing the laſt Letter, No. VI. was to prepare the way for a true calculation of Ptolemy's eclipſes upon Ptolemy's data, in the months and days of the Julian year, correſponding aſtronomically with the months and days of the Egyptian year, aſſigned in the Almegiſt. An acquiſition this, which may be juſtly reckoned amongſt the deſiderata.

Should you think it worth the while to make the experiment, you would ſoon be ſenſible that the preceding determination will effectually conduce to the end propoſed.

In proof of this, let it be required to calculate the Julian month, day of the month, hour, and minute, on which the ſun came to the vernal equinox at Alexandria, in the year of the aſtronomical Julian period 3287, which falls in with the year from Nabonaſſar 27.

Here it will be again neceſſary to ſubjoin

A TABLE of the times of the Sun's entry into the four Cardinal Points of the Ecliptic, for the firſt four Years of the Reign of Nabonaſſar, in the Months and Days of the Julian Year, calculated for the Meridian of Alexandria.

Yrs of a Quadriennium.	Yrs of the Aſtronomical Jul.Period.	☉ in ♈ Month March.			☉ in ♋ Month June.			☉ in ♎ Month Sept. Oct.			☉ in ♑ Month Decem.			
		D.	H.	M.	D.	H.	M.	D.	H.	M.	D.	H.	M.	
0	3260	-	-	-	-	-	-	-	-	-	29	6	42	p.m.
1	3261	28	8	43	29	7	25	30	20	34	29	12	31	
2	3262	28	14	32	29	13	14	1	2	23	29	18	20	
3	3263	27	20	21	28	19	3	30	8	12	29	0	9	
0	3264	28	2	10	29	0	52	30	14	1	29	5	58	

The

The CALCULATION.

Divide the year from Nabonaſſar 27 by 4, and the quotient will give 6d. 18h. for the retroceſſions of Thoth: but it being a biſſextile year in the Julian form, as the remainder 3, after the diviſion of 27 by 4, denotes; we complete the odd 18 hours into a day, which will make 7 days for the retroceſſions of Thoth.

Look for the number 3 in the margin of the Table, and in the ſame parallel line, under ☉ in ♈, will be found theſe times—March 27d. 20h. 21m. p.m. from which ſubtract 4h. 24m. for the retroceſſions of the equinox in 24 years, and it will give March 27d. 15h. 57m. p.m. for the time of ☉ in ♈ at Alexandria, in the given year.

From March 27d. ſubtract the integral epact 7. (Letter III. p. 10.) and it will carry it back to March 20d. for the day of the full moon next before the vernal equinox, an. ær. Nabonaſſ. 27.

Again, from March 27d. 15h. 57m. p.m. the calculated time of the vernal equinox at Alexandria, ſubtract for the mean aſtronomical full-moon epact 7d. 7h. 14′ 26″ (Letter III. p. 11.) and it will carry it back to March 20d. 8h. 42′. 34″, for the mean time of full moon, in the ſame meridian, preciſely.

From 8h. 42′ 34″, ſubtract 8h. 40m. for the recorded middle time of the eclipſe at Alexandria; and it will leave in remainder 2′ 34″, for the difference between the mean time of that eclipſed full moon and the true.

We ſhall find the ſame Julian month, and day of the month, if we compute from February 28, the true Julian epoch of the firſt Nabonaſſarean year. *E. g.*

The 28th day of February is the 59th day à kal. Jan. From 59d. ſubtract 1, and it will leave in remainder 58; from which ſubtract 7 for the retroceſſions of Thoth; and it will carry it back to the 51ſt day à kal. Jan. To 51 add Thoth 29, and from the ſum 80, ſubtract 60, for the 29th of February in a biſſextile year; and it will give March 20 for the day of full moon, next before the vernal equinox, as above.

We will now take for a radix that mean full moon, which will happen the next but one after the vernal equinox, A. D. 1780, and calculate backwards from thence to the 27th year from Nabonaſſar, and ſee how the full moon next before the vernal equinox in that year will fall in this mode of calculation.

	D.	H.	′	″	‴	
From April 7d. à kal. Jan.	97	19	52	27	30 m.	Full moon next but one after ☉ in ♈, A. D. 1780.
Subtract for 2500 years	18	11	9	53	30	
Full moon, as above, March 20 ————	79	8	42	34	00	

If theſe calculations, when taken together, will not give the critical examiner full fatisfaction, I ſhould be glad to know what would?

But now here comes the deciſive query: By what arguments may it be proved, that March 20, the calculated day of full moon, and March 27, the calculated day of the vernal equinox, are in a true aſtronomical connection; the former with Thoth 29, the recorded day of full moon; and the latter with the 6th of Paophi, the calculated day of the vernal equinox in the Egyptian year?

Here the anſwer is, That this true aſtronomical connection may be proved by two arguments: 1ſt, By the identity of the mean aſtronomical full-moon epact, whoſe variety is inexhauſtible. This indefinite variety renders it ſuch an appropriated character, that it cannot return under the ſame preciſe quantity, in an immenſe ſeries of epacts. 2dly, By the day of the week.

Now therefore, let it be required to aſcertain the day of the week correſponding aſtronomically, 1ſt, with the 29th of Thoth, the recorded day; 2dly, with the 20th of March, the calculated day of full moon; both of which came next before the vernal equinox, an. ær. Nabonaſſ. 27, not only 7 entire days, but alſo 7d. 7h. 14′ 26″: which makes the argument concluſive.

Thus, then, I frame the calculation of the day of the week, correſponding aſtronomically with the 29th of Thoth.

3286

3286 ſolar tropical years, and 6 months, include 40648 lunations, which give, by reduction, 1200358 days; the laſt of which terminates on the day of the eclipſed full-moon. To theſe add 4, then divide the ſum total, 1200362 days, by 7, and it will leave in remainder 2 for the numeral character of the day of the week ſought.

For the right underſtanding of this numeral character 2, we muſt have recourſe to the ſubjoined

TABLE of the DAYS of the WEEK,

Which are ſet down, as they are computed, not by the Jews, but by the Chriſtians.

	Mond.	Tueſd.	Wed.	Thurſd.	Frid.	Saturd.	Sund.
Numer. Charac.	1	2	3	4	5	6	⊙
Literal Charac.	A	B	C	D	E	F	G
	B	C	D	E	F	G	A
	C	D	E	F	G	A	B
	D	E	F	G	A	B	C
	E	F	G	A	B	C	D
	F	G	A	B	C	D	E
	G	A	B	C	D	E	F

I look into this Table for the numeral character 2, and find directly over it——Tueſday, which is the day of the week correſponding aſtronomically with the 29th of Thoth, in the year of the aſtronomical Julian period 3287, an. ær. Nabonaſſ. 27.

In the next place, let it be required, to aſcertain the literal character of March 20, the calculated day of full-moon. But firſt, it will be neceſſary to find the Dominical letter for the given year.

In order to this, divide the year 3287 by 28, and it will leave in remainder 11, for the cycle of the ſun. But before we can apply it rightly, we muſt conſult the ſubjoined

TABLE of the Dominical Letters, which are adjuſted, not to the Artificial, but to the Aſtronomical Julian Period.

1 F	5 A	9 C	13 E	17 G	21 B	25 D
2 E	6 G	10 B	14 D	18 F	22 A	26 C
3 DC	7 FE	11 AG	15 CB	19 ED	23 GF	27 BA
4 B	8 D	12 F	16 A	20 C	24 E	28 G

The calculated cycle of the ſun is 11, which in the table gives AG for the dominical letters; A for the two firſt, and G for the laſt ten months of the year.

I look into the Table of the Days of the Week, in the outermoſt column on the right hand, under Sunday, for G; and in the ſame parallel line, under Tueſday and the numeral character 2, I find B, which is the literal character of March 20, and of March 27, in the Julian kalendar, and for that year after February, denoted Tueſday.

The Table, which was conſtructed for the calculation of the day of the week, throughout all ages of the world, whatever year, month, or day of the month, may be given, will hold uniformly true: and ſhould it ever be diſcovered to fail in any one inſtance, out of more than twenty times 100,000,

Emendaturis ignibus ipſe darem.

I ſhall only add, Should you find your ſelf able to aſcertain, by any of the common tables, the day of the month, firſt in the Egyptian, (and then in the Julian year) on the evening of which any one of Ptolemy's eclipſes is ſaid to have been obſerved; you will from thenceforth be relieved from the trouble of any future addreſs; hoping you will take this in good part from,

Reverend Sir,
Your ſincere well-wiſher,
JOHN KENNEDY.

P. S. As there are ſeveral articles in the foregoing Letters, which are but barely mentioned, I am very ſenſible, that without the help of ſome comment, or further explanation, I ſhall too ſtrongly verify Horace's remark,

> ————————*Brevis eſſe laboro,*
> *Obſcurus fio.*————

In Letter II. (p. 7.) the year from Nabonaſſar 27, is found in connection with the year of the aſtronomical Julian period 3287. And, in Letter IV. (p. 12.) the year from Nabonaſſar 2527, with the year 5787.

Letter II. (p. 7.) the year 3286 being divided by 19, gives in the quotient 172 entire cycles. And in Letter IV. (p. 14.) the year 5786, being divided by 19, gives 304. In Letter III. (p. 10.) the ſum of the days anſwering to 172 entire cycles were 13; from which ſubtracting 1, there remained 12 d.

In Letter IV. (p. 14.) the ſum of the days anſwering to 304 entire cycles were 24—from which ſubtracting 2, there remained 22 d.

But in order to obviate an objection which every intelligent reader would naturally make, namely, That theſe ſubtractions muſt be thought arbitrary, they not being ſupported by any apparent ratio, or the leaſt ſhadow of authority, I immediately ſubjoined—"the reaſons of which (ſubtractions) will be explained hereafter."

But

But before I formally enter upon theſe explanations, it may, firſt, be expedient, ſhould any one perchance be inclined to make a trial of my mode of calculation, to lay down the four following general Rules, as a ſtanding directory.

But let it be obſerved, that, although this directory will faithfully diſcharge its office, yet it cannot give any light into the true aſtronomical grounds and reaſons of theſe ſubtractions, or the latent cauſes of this neceſſity. For this I muſt refer to the Explanatory Appendix.

RULE I.

If any year be given, which comes before the vulgar Chriſtian æra, or before A. D. 10, ær. vulg. 1 day muſt be ſubtracted from the ſum total of days in the lunar reduction, and from the collected ſum of the cyclic numbers; otherwiſe, the calculations made downwards, from the original radix to a given year, will invariably terminate on the day after a mean new or full moon.

RULF II.

If any year be given, which comes after, or lower down in time, than the year of the aſtronomical Julian period 4017, A. D. 10, ær. vulg. 2 days muſt be ſubtracted from the ſum total of days in the lunar reduction, and from the collected ſum of the cyclic numbers; otherwiſe, the calculations made downwards, from the original radix to a given year, will invariably terminate on the ſecond day after a mean new or full moon.

RULE III.

If any mean new or full moon be taken for a radix in the current 18th century of the Chriſtian æra, the given year lying higher up in time than the year of the aſtronomical Julian period 4017, A. D. 10, ær.

vulg. and the calculations be made backwards through complete centuries; 1 day muſt be ſubtracted from the tabular numbers, or, which is all one, be added to the radical new or full moon; otherwiſe, the calculations will invariably overpaſs, ſometimes 1, and ſometimes 2 days current, the new or full moon propoſed.

RULE IV.

If any year be given, which comes lower down in time than the year of the aſtronomical Julian period 4017, A. D. 10. ær. vulg. either 1 day muſt be ſubtracted from the lunar reduction, or be added to the exceſs of the Julian computation above the lunar; otherwiſe, the calculations can never be made to coincide with the mean new moon or full moon propoſed.

N. B. What is here ſaid of theſe four Rules, are not points to be diſputed, but matters of fact to be tried: and if tabular calculations, made backwards through more than 17 centuries, (excluſive of that which is current) can be of any ſervice to the public, they ought to be tried.

AN EXPLANATORY
APPENDIX
TO THE FOREGOING
LETTERS.

THE pillars upon which my Syſtem of Chronology is built, are theſe few, plain, ſimple principles enſuing; namely, 1ſt, A true luni-ſolar radix, or determinate poſition of the ſun and moon to each other at the creation. 2dly, A true uninterrupted ſeries of years (both Julian, and ſolar tropical) collected from the evidences of ſacred and profane Hiſtory. 3dly, A true length of the ſolar tropical year. 4thly, A true length of a mean lunation or ſynodical month. 5thly, A true meridian diſtance, for the connection of the firſt meridian with our own. By the Firſt Meridian, here, is meant that meridian which lies 156 degrees weſtward of the meridian of the Greenwich obſervatory (vid. Syſt. of Chronol. p. 169) whoſe correſponding time upon the æquator, is 10h. 24′; which are the numbers of an obſervation made by the late Reverend Dr. Bradley, of an autumnal equinox, at Greenwich, A. D. 1753: and when he delivered it into my hands, with ſome others, he aſſured me they were made with the utmoſt care and diligence.

Now, ſhould any one actually be poſſeſſed of theſe few principles, with a required exactneſs; might it not reaſonably be aſked, From whence could a ſenſible error ariſe? How far I may be actually poſſeſſed of them, the reader will be able to judge from the ſubſequent calculations; for the baſis of which I ſhall take two entire Julian periods, which may be ſuppoſed to follow, the one the other, in immediate ſucceſſion. And we will alſo ſuppoſe, that the one ended, and the following began, at the moment of the autumnal equinox; as it is expreſſed by the ſymbol which I have placed between them.

I.		II.
The Proleptical Julian Period, containing 7980 Years.	♎ ☉	The current Aſtronomical Julian Period, containing 7980 Years.

With reſpect to the lunar characters, the immediate purport of the calculations will be to prove, that the proleptical Julian period ended on the day of a full moon; and that the current aſtronomical period commenced on the day after that full moon: and if I prove this, I ſhall at the ſame time lay open, and prove, the true aſtronomical grounds and reaſons of Rule I. (p. 28.)

As the ſteps of the calculations will be many, I could wiſh, that they might be critically examined, minutely ſcrutinized, and every neceſſary proof of their truth be demanded; ſince much depends upon them, as it will be evinced in the ſequel.

The Julian period is compounded of 7980 mean Julian years, each of them conſiſting of 365d. 6h.

Every Julian mean year has its inherent ſolar tropical year, each of them conſiſting of 365d. 5h. 49m. The annual difference is 11′. Every ſolar tropical year has its inherent lunar year. Every lunar year has its annexed epact; which is as ſure to follow the expiration of a lunar year, as every ſolar tropical year is to follow that which came immediately before it.

The epact is not only the meaſure of the diſtance between the end of a lunar year, and the beginning of the next ſolar tropical year in ſucceſſion; but as it always includes the terminating 5h. 49m. it thereby becomes the aſtronomical band of union, I may ſay, the Buckle, which cloſely connects the two incommenſurate years.

If we go back in our imagination to the beginning of the firſt year of the current aſtronomical Julian period, the various combinations of the 3 cycles of the ſun, moon, and indiction, will there be reſolved into unity.

The cycle of the ſun	will be	1
The cycle of the moon		1
The cycle of the indiction		1
The golden number		1
The integral and aſtronomical full moon epact, alſo *(ex hypotheſi)*		1

I have added the terms *ex hypotheſi,* becauſe I am to prove, by calculation, that the original full-moon epact was 1 entire day.

Having premiſed thus much, I proceed to

The CALCULATIONS.

1. From the year of the aſtronomical Julian period 7980 ſubtract the year 4007, and it will diſcover a connection with A. D. 3973.
2. The following articles I ſhall call Poſtulata, although I ſhould rather chuſe to call them Original, or Firſt principles.

POSTULATA.

I. That time commenced at the moment of the autumnal equinox.—II. In the firſt meridian, at noon.—III. On the 4th day of the week, which we call Thurſday.—IV. On the day after a full moon.

By the help of theſe Poſtulata, or firſt principles, we ſhall be enabled to interpret, in a determinate aſtronomical ſenſe, every ſolar tropical, and lunar reduction of years to days, which can be made. *E. g.*

3. If we apply to the ſolar tropical tables, and take from thence the number of days anſwering to 7980 years, the collected ſum will be 2914634d. 1h. 00m. p.m. Throw off the entire days, and there will remain theſe characters, 1h. 00m. p.m.

Now by the help of Poſtulatum I. we are directed to ſay, that in the year of the current aſtronomical Julian period 7980, A. D. 3973, the ſun will come to the autumnal equinox, in the firſt meridian, at one o'clock in the afternoon preciſely.

4. To the ſum of the days in the ſolar tropical reduction, add 4, (by Poſtulatum III.) then dividing the ſum total 2914638d. by 7, it will leave in remainder 6, which by the Table of the Days of the Week (p. 25.) denotes Saturday.

5. Divide 7980 by 4, and the remainder 0 will ſhew, that it was the 4th year of a quadriennium, which anſwers to the firſt after biſſextile in the Julian computation.

6. Now we have here ſuch a combination of characters, as cannot be found all together in any two years throughout the period.

For the ſun cannot enter any one of the cardinal points of the ecliptic twice, 1. At a given hour and minute. 2. On a given day of the week. 3. In a given year of a quadriennium, or after biſſextile. 4. In a given meridian, in leſs than 10080 years.—Vid. Syſt. of Chronol. p. 196.

Let thoſe refute this doctrine who can.

7. In the next place, let it be required to find the number of days in 7980 Julian years, without applying to the tables.

Multiply 7980 mean Julian years into 11′, and it will give 60d. 23h. for the retroceſſions of the equinox in that interval.

	D.	H.	M.	
To the ſolar tropical reduction	2914634	1	00	p. m. ⊙ in ♎.
Add for the retroceſſions of the equinox ——	60	23	00	
The ſum will be the Julian reduction required —	2914695	00	00	⊙ in ♎

From hence it is evident, that the firſt of theſe 7980 Julian years commenced at the moment of the ſun's entry into the firſt point of Libra, in the firſt meridian, at noon, whoſe characters are 0h. 0m.

The LUNAR COMPUTATION.

II.

8. Here let the enquiry be, On what day of the moon's age, or rather, on what diſtance after full moon, will the ſun croſs the equator, at the autumnal equinox, in the year of the aſtronomical Julian period 7980, A. D 3973?

As I have ſaid, At what diſtance after a full moon, will the ſun croſs the equator at the autumnal equinox, in the year 7980, A. D. 3973? it may be neceſſary to lay down the following axioms.

AXIOM I.

9. If a ſeries of ſolar tropical years be given, from which ſoever of the four cardinal points of the ecliptic the firſt of them be computed, the laſt in the ſeries muſt neceſſarily terminate on the ſame.

AXIOM II.

10. If a ſeries of lunar years, or lunations, be given, from which ſoever of the two principal lunar phaſes the firſt of them be computed, the laſt in the ſeries muſt neceſſarily terminate on the ſame.

11. The preſent enquiry will naturally lead me to calculate the full-moon epact, both integral and aſtronomical.

I ſhall lay down four Rules for the calculation of the integral epact, and two for the aſtronomical.

The calculation of the integral full-moon epact, at the autumnal equinox in the year 7980, A. D. 3973.

RULE I.

In 30 lunar years there are 10631 entire days.

12. D.
Divide by —— 10631)2914634(274 periods of 30 lunar years thrown off.
Divide the remainder by —— 354)1740(4 lunar years thrown off.
From the remainder ——)324(
Subtract for lunar years of 355 days —— 1
From the remainder —)323 1 lunar year of 355 days [thrown off.
Subtract for 10 lunations)295
The integral full moon epact 28. 10 lunations thrown off.

RULE II.

13. In 30 lunar years there are 19 of 354 days, and 11 of 355. Multiply the 274 periods of 30 lunar years, in the firſt quotient, into 11, and to the product 3014, add for 4 ſingle years 1; then the ſum of the lunar years of 355 days will be 3015.

D.

From the ſolar tropical reduction —— } ——2914634

Subtr. for lunar years of 355d. 3015

Divide the remainder by 354)2911619(8224 lunar years thrown off.

From the remainder —— 323

Subtract for 10 lunations —— 295

Remains the integral full moon epact 28. 10 lunations thrown off.

RULE III.

14. Required the number of days in 8224 lunar years.

Multiply —— 8224 lunar years

into —— 354 days.

To the product —— 2911296

Add for lunar years of 355d. 3015

To the ſum —— 2914311

Add for 10 lunations —— 295

The ſum —— 2914606

From the ſolar tropical reduction — 2914634

Subtract the lunar —— 2914606

Remains the integral full-moon epact — 28

RULE IV.

15. Divide 7980 by 19, and the quotient will give 420 entire cycles; the tabular numbers (Tab. II. p. 9.) anſwering to 420 cycles, when collected into a ſum, are 31d. 18h. 58′ 45″.

From

	D.	H.	′	″	‴
From the ſum of 2 lunations	59	1	28	3	30
Subtract for 420 cycles	31				
The integral full-moon epact	28				

The calculation of the aſtronomical full-moon epact.

RULE I.

16.

	D.	H.	′	″	‴
From the ſum of 2 mean lunations ——	59	1	28	3	30
Subtract for 420 cycles ——	31	18	58	45	00
Remains the aſtron. full-moon epact	27	6	29	18	30

RULE II.

17. 8224 lunar years + 10 lunations contain 98698 lunations;

	D.	H.	′	″	‴
Which give by reduction,	2914606	18	30	41	30
From the ſolar tropical reduc.	2914634	1	00	00	00
Sub. the lunar for 98698 lunat.	2914606	18	30	41	30
Remains the mean aſtronomical full-moon epact ——	27	6	29	18	30

18.

	D.	H.	′	″	‴
To the reduction of 98698 lunations,	2914606	18	30	41	30
Add for 2 lunations ——	59	1	28	3	30
The ſum is the reduction of 98700 lunations ——	2914665	19	58	45	00

The laſt of theſe days terminates on that full moon which will come the next but one after the autumnal equinox, in the given year.

19. Now let it be required to find the ſtation of the original full moon, and its preciſe diſtance before the original autumnal equinox.

	D.	H.	′	″	‴
To the reduction of 98700 lunations	2914665	19	58	45	00
Add, by Rule IV. ——	1				
To the ſum ——	2914666	19	58	45	00
Add, for 1 lunation ——	29	12	44	1	45
From the ſum ——	2914696	8	42	46	45
Subtract for 7980 Julian years ——	2914695				
The remainder is ——	1	8	42	46	45

	D.	H.	′	″	‴
From a mean lunation ——	29	12	44	1	45
Subtract the laſt remainder ——	1	8	42	46	45
Remains ——	28	4	1	15	00

	D.	H.	′	″	
20. To the reduction of 98700 lunations,	2914666	19	58	45	
Add the laſt remainder ——	28	4	1	15	
The hour and minute of the original full moon	2914694	00	00	00	noon.

	D.	H.	M.
From the Julian reduction	2914695	00	00
Subtract the lunar ——	2914694	00	00
Remains the original full-moon epact	1		

21. An aſtronomer would call this remainder, under No. 19, namely, 28 d. 4 h. 1′ 15″ 00‴, the lunar anticipations for 420 cycles: and that it is ſo, will clearly appear under the Julian lunar computation. But it may be readily proved, by a very eaſy calculation.

	D.	H.	′	″
From the Julian reduction of 7980 years, ——	2914695	00	00	00
Subtract the lunar reduction of 98700 lunations	2914696	19	58	45
The remainder, as before,	28	4	1	15

Thus

22. Thus we have aſcertained, by a few eaſy calculations, the original full-moon epact; and have clearly ſhewn, that it came 1 entire day before the original autumnal equinox. We have now, therefore, ſomething more to plead, than a mere fancifull hypotheſis, for ſetting down the following numbers in this identical form.

Cycle of the Sun	Cycle of the Moon	Golden Number	The Integral and Aſtronomical Full-Moon Epact
1.	1.	1.	1.

Here let this peculiarity be obſerved: The mathematical coincidence of the integral and aſtronomical full-moon epact could not be found again, in the ſame meridian, ſhould 10,000 Julian periods follow one another in an uninterrupted ſucceſſion. This is a very diſtinguiſhing character of the original luni-ſolar radix.

It might be clearly ſhewn, by an induction of particulars, that many ſignal advantages will accrue to practical aſtronomy, from the calculation of this original luni-ſolar radix, ſo mathematically true. Its truth and certainty will be proved by its practical application through the whole interval from the year of the creation to the preſent times.

We will now go on to

The JULIAN SOLAR COMPUTATIONS.

Although the preceding calculations, which compute the ſun and moon's places, in the ſolar tropical kalendar, may be ſufficiently complete, with reſpect to abſtract aſtronomy; yet, in order to render them the more intelligible to the generality of readers, it may be expedient to compute them alſo in the Julian.

1. Here, Firſt, let it be required to calculate the Julian month, day of the month, day of the week, with the hour and minute on which the ſun will come to the autumnal equinox, in the year of the aſtronomical Julian period, 7980, A. D. 3973.

A. D. 3973, will be the 1ſt after Biſſextile; ſo alſo was A. D. 1753, when the ſun was obſerved to enter Libra, at Greenwich, O. S. September 11d. 10h. 24m. p. m.

2. The interval is 2220 years; which, being multiplied into 11, will give 16d. 23h. 00m. for the retroceſſions of the equinox.

3. To September 11d. add the 31 days of Auguſt; then from the ſum, 42 d. 10 h. 24 m. p. m. ſubtract 16 d. 23 h. 00 m. for the retroceſſions of the equinox in 2220 years, and it will carry it back to Auguſt 25 d. 11 h. 24 m. p. m. for the time of the equinox at Greenwich, in the given year.

4. From Auguſt 25d. 11h. 24m. p. m. the time of the autumnal equinox at Greenwich, ſubtract 10h. 24m. for the difference of longitude in time, between the firſt meridian, and that of the Greenwich obſervatory; and it will leave in remainder Auguſt 25d. 1h. 00 m. p. m. for the time of the equinox in the firſt meridian; as in a former calculation, (p. 33).

5. Required, the literal character of Auguſt, 25 d.

If we divide 7980 by 28, it will leave in remainder 0, i. e. 28 for the cycle of the ſun; which in the Table (p. 26.) gives G for the Dominical letter. The numeral character (p. 33) was by calculation 6: I look into the Table of the Days of the Week (p. 25.) under Sunday, for G; and in the ſame parallel-line, under the numeral character 6 I find F, which is the literal character of Auguſt 25; and for that year denoted Saturday.

6. Let it be required, to determine in what Julian month, on what day of the month, and at what hour and minute, the proleptical Julian period ended, and the current aſtronomical Julian period commenced.

7. It appears (p. 34.) that the retroceſſions of the equinox in 7980 years amount to 60d. 23h. 00 m.

8. To Auguſt 25, à kal. Jan. 237d. 1h. 00m. p. m. the time of the autumnal equinox, in the firſt meridian, add 60d. 23h. for the retroceſſions of the equinox, and it will carry it down to October 25d. à kal. Jan. 298d. 00h. 00m. p. m.

9. We ſay then, that if the Julian ſtyle be extended backwards from the autumnal equinox, A. D. 3973, 7980 years, it will appear, that the proleptical Julian period ended, and the current aſtronomical Julian period commenced, on the 25th of October, in coincidence with the moment of the autumnal equinox, at noon, in the firſt meridian. Proceed we now to

The JULIAN LUNAR COMPUTATION.

1. Let it be required, to calculate the mean time of that full moon, which will happen next before the autumnal equinox in the year of the aſtronomical Julian period, 7980, A. D. 3973.

2. From Aug. 25d. 11h. 24m. p. m. the time of the autumnal equinox at Greenwich, in the given year, ſubtract the mean aſtronomical full-moon epact, 27d. 6h. 29′ 18″ 30‴, (p. 37.) having firſt added the 31 days of July, which will make 56d. 11h. 24m. 00″

	D.	H.	′	″	‴	
From	56	1	00	00	00	
ſubtract	27	6	29	18	30	calculated (p. 37.)
F.M.July	28	18	30	41	30	p. m. next before ⊙ in ♎ A. D. 3973.

3. Required, the mean time of that full moon, which will come next after the autumnal equinox, in the ſame year, and in the ſame meridian.

If we divide 7980 years by 19, the quotient will give 420 cycles without a remainder. The numbers in Table II. (p. 9.) anſwering to 420 cycles, were (p. 37.) 31d. 18h. 58′ 45″ 00‴. From hence ſubtract 1 lunation, and it will leave in remainder 2d. 6h. 14′ 43″ 15‴.

To Auguſt 25d. 1h. 00′ 00″ 00‴, the time of the autumnal equinox, firſt meridian, add the remainder 2d. 6h. 14′ 43″ 15‴; and it will bring it down to Auguſt 27d. 7h. 14′ 43″ 15‴ p. m. for the mean time of full moon next after the autumnal equinox, in the firſt meridian, in the ſame year.

4. To Auguſt 27d. 7h. 14′ 43″ 15‴ add 1 lunation, and it will bring it down to September 25d. à kal. Januar. 268d. 19h. 50′ 45″, for the mean time of full moon, the next but one after the autumnal equinox, in the given year.

5. There only remains to be calculated, the exact meaſure of the diſtance between this laſt full moon, and the moon's original Julian ſtation.

Here an aſtronomer, who conſtantly calculates the Julian ſtation of the moon, would probably argue, upon this occaſion, in the following manner.

At the end of every 19 Julian years, the mean new moons, and the mean full moons, fall earlier by about an hour and an half. This earlier happening of the mean conjunctions and oppoſitions, the

Greeks called προηγησις σεληνιακη; and we, the Lunar Anticipations.

In my Syſtem of Chronology, (p. 427) is inſerted a Table of theſe Anticipations, to 300 cycles; and the numbers in this Table, anſwering 420 cycles, when collected into a ſum, will amount to 27d. 4h. 1′ 15″; to which 1 day being added by Rule IV. the ſum will be 28d. 4h. 1′ 15″; which is the exact meaſure required.

Notwithſtanding this, theſe calculations muſt needs be artificial, with reſpect to their mode; becauſe the Julian is not the natural year: and although I ſhall, by my calculations, obtain the ſame individual meaſure, yet I ſhall not conſider it, with the aſtronomer, as the ſum of the lunar anticipations, but as, what it really is in nature, the complement of a mean lunation. Had the aſtronomers known the original Julian ſtation of the moon, and of the ſun, to the preciſion of a moment, we ſhould never have heard of the doctrine of Lunar Anticipations.

Here follow my CALCULATIONS.

	D.	H.	′	″	‴
To September 25d. à kal. Januar.	268	19	58	45	
Add by Rule IV. ——	1				
To the ſum ——	269	19	58	45	00
Add for 1 lunation —	29	12	44	1	45
From the ſum	299	8	42	46	45
Subtract, for Octob. 25h. om. à kal. Jan.	298				
Remainder	1	8	42	46	45
From the quantity of a mean lunation	29	12	44	1	45
Subtract the remainder —	1	8	42	46	45
Remains the complement of the lunation	28	4	1	15	00
To September 25d. à kal. Januar.	268	19	58	45	
Add for the meaſure required ——	28	4	1	15	
The orig. Julian ſtation of the f. m. Oct. 24	297	00	00	00	noon.

	D.	H.	M.	
From October	25	00	00	The original Julian ſtation of the autumnal equinox.
Subtract Octob.	24	00	00	The original Julian ſtation of full moon.
Remains	1	00	00	For the original full-moon epact.

To give a clear idea of the ſituation of this original full-moon epact, we will ſet it down in the following manner.

	D.	H.	M.	
7980 Julian years contain ———	2914695	00	00	☉ in ♎
Theſe include 98700 lunat. which give	2914694	00	00	f. moon.
The difference	1			

From hence it is evident to ſenſe, that this full-moon epact is the laſt day of the proleptical Julian period; and as that proleptical period ended with the day of a full moon, it is certain, that the firſt lunar year, and the firſt lunation which followed next after the autumnal equinox, muſt begin on the day after a full moon.

Hence it comes to paſs, that if we compute downwards to the preſent times, by complete lunar years, and complete lunations, from the day of the original autumnal equinox, from which time is computed; not only the laſt lunation in the ſeries, but every one of them in ſucceſſion, muſt terminate on the day after a full moon. From hence ariſe the grounds and reaſons of Rule I. p. 28.

It may, and I ſuppoſe it will, be thought an incredible peculiarity, that all the art of man cannot bring this original full-moon epact 1 within the limits of meaſured time, by the reduction of ſolar tropical years, and lunations to days; and it will rack the brain of the acuteſt phyſiologiſt, to inveſtigate the natural reaſon of it. A phyſical cauſe there can be none; although a final one there may be: but I ſhall not preſume, at preſent, to give my judgement about it.

III.

I ſhall now attempt to unfold the grounds and reaſons of Rule II. p. 28.

The neceſſity of ſubtracting 2 days, as directed by Rule II. is another article, the knowledge of which is of prime importance in a general ſyſtem of chronology; but as it is reſolvable into an aſtronomical principle, it will not require any very elaborate explanation to make it quite intelligible.

In order to this, I ſhall tranſcribe part of a Table, from my Syſtem of Chronology, (p. 209) as much as may ſerve my preſent purpoſe.

		D.	H.	'	"	
30 Lunar years contain		10631	00	10	30	
Periods.	**Lunar years.**					
1	30	00	00	10	30	p.m. Firſt Meridian.
60	1800	00	10	30	00	
120	3600	00	21	00	00	
137	4110	00	23	58	30	
138	4140	1	00	9	00	

It may be proper to obſerve, that the original epact 1 expreſſes the diſtance of full moon before the original autumnal equinox, with a mathematical preciſion; it being extended from the noon of the third day of the week, which we call Wedneſday, to the noon of the fourth, which we call Thurſday; and there terminating in coincidence with the moment of the ſun's ingreſs into the firſt point of Libra, in the firſt meridian.

Now, in this Table, the hours, minutes, and ſeconds, annexed to the lunar years, repreſent to the view the gradual and uniform departure of mean full moon, from its original coincidence with noon—the diſtance from the equinox being of no account.

Suppoſe a mean full moon ſhould happen in our meridian, in any year, preciſely at noon.

Then, it appears from this Table, 1ſt, That at the end of 30 lunar years, it would happen at 10′ 30″ p. m. in the ſame meridian.

2dly, At the end of 60 periods, or 1800 lunar years, it would happen at 10h. 30m. p. m. in the ſame meridian.

3dly, In the end of 120 periods, or 3600 lunar years, it would happen at 21 hours after noon, in the ſame meridian.

4thly, In the end of 137 periods, or 4110 lunar years, it would happen at 23h. 58′ 30″ p. m. in the ſame meridian; which wants but one minute and a half of returning to a coincidence with noon again: but notwithſtanding this approximation, it would require more than 600,000 years to bring about a coincidence with noon again, in the ſame meridian.

5thly, At the end of 138 periods, or 4140 lunar years, the mean full moon will have traverſed the whole equator eaſtward, and would begin another circulation at 9′ after noon, in the ſame meridian.

Thus then theſe 10′ 30″ would gradually and uniformly increaſe into 1d. + 9h. And if this redundant day be not thrown off, the calculations, inſtead of falling upon the day of full moon, would fall 1 day after it; ſuppoſing no other cauſe of ſubtraction.

There is ſomething very analogous to this in the ſolar tropical computation; for, as it is well known that the ſun enters the cardinal points 11′ earlier every year (as the mean full moons fall out 10′ 30″ later every 30 years) and that in the ſpace of 131 years, theſe 11′ gradually increaſe into 1 day + 1′; if this redundant day be not thrown off, the calculations, inſtead of falling upon the day of the equinox or ſolſtice, would fall 1 day after it.

There remains only this queſtion to be anſwered; namely, When was this redundant day completed?

The anſwer, ſaving the trouble of calculation, is, That the 4140th lunar year terminated, and this redundant day was completed, 1. In the year of the aſtronomical Julian period, 4017. 2. In the year of our Lord 10, ær. vulg. 3. On the 15th day of June, and at that full moon which came next before the ſummer ſolſtice in that year.

In this year, on this month, and on this day of the month, the tables will find a full moon; whilſt my calculations made downwards to the given year, would protrude it forwards to the 17th of June; and as this protruſion is unavoidable, hence ariſes the neceſſity of ſubtracting 2 days, in order to carry it back to the day of full moon.

After what has been ſaid, I ſuppoſe, that the reader is fully ſatisfied concerning the neceſſity of this ſubtraction. But theſe reaſons, as any one may perceive, do not ſwim upon the ſurface: I was obliged to dig deep for both of them.

So that how negligently ſoever this Table of Triacontaeterids may have been paſſed over, either upon the account of its novelty, or ſome other cauſe; I am now ſo bold as to ſay, that without a previous knowledge and right underſtanding of the principles upon which it is conſtructed, and without a ſtrict regard had to its numerical contents, the common tables, in their calculations backwards to a remote age, will be of no uſe at all for any more than 17 centuries, as it has been already obſerved, excluſive of that which is current.

I could confirm this account by a variety of examples; but they would carry me too far.

As

IV.

As the reaſons of Rules III. and IV. differ only in the mode of calculation, a very few words will ſerve to explain them.

If any mean new or full moon be taken for a radix, after the completion of this redundant day, and the calculations be carried backwards more than 17 centuries, to an age in which it was not completed; it is obvious to common apprehenſion, that if a redundant day be ſuffered to intermix itſelf with the calculations, and to be carried back along with them, it muſt neceſſarily cauſe them to fall beyond the propoſed new or full moon; not to mention other unſuſpected cauſes, which would carry them higher up ſtill.

Hence it is, that the days of the month, on which the new moons and full moons happened, have never been rightly calculated by the tables, nor poſſibly can be, for a long ſeries of more than 4000 years.

V.

In the end of Letter II. I have inſerted a Table, No.I. of 19 Vernal-equinoctial Full-moon Epacts (and Three more of the ſame kind, for the other cardinal points, are ready to be produced) and likewiſe (No II) a Table of Cyclic Numbers.

If I might be excuſed the freedom, I would recommend theſe Tables, not only to the critical examination, but to the attention too, of the learned and ingenious Dr. Blair; and I could wiſh he would try to diſcover and explain the principles upon which they are conſtructed; and likewiſe to trace out the true grounds of their mutual dependance upon, and cloſe aſtronomical connection with, each other.

The intrinſic merit of theſe Tables is this: With reſpect to accuracy, it is quite a matter of indifference, whether we calculate 50 cycles, or three times 500. The numbers are ſo perfect, that they will ſtand in need of no correction for an indefinite number of ages: nor will they require the leaſt alteration, until at the autumnal equinox, in the year of the aſtronomical Julian period 7432, A. D. 3425; then, and not till then, they muſt be new modelled, which may readily be done without any difficulty at all.

VI.

It may be thought, perhaps, that I have given too great an importance to the correſponding day of the week; a much greater than it can lay a claim to. But in anſwer to this, it may be proved, upon true principles of aſtronomy, that the day of the week, in union with an equinox or a ſolſtice, or a new moon, or full moon, is ſuch a diſtinguiſhing character, that it would be no eaſy taſk to determine, by the indefinite powers of numbers, in what limited ſpace of time the ſun can return to a given point of the ecliptic, 1. On a given day of the moon's age. 2. On a given day of the week. 3. In a given meridian. And, 4. If to theſe we add the hour and minute of an equinox, or a ſolſtice; or of a mean new or full moon; What ſhall we think of the immenſe ſpace of more than 60,000,000 years?

VII.

Ptolemy has recorded, and I have calculated, the coincidence of a full moon with the 20th of Thoth, the firſt month of the vague and erratic Egyptian ſolar year.

Should authority enjoin a calculation of ſuch coincidence (excluſive of the eclipſe, which it would be but loſt labour to attempt) by any of the common tables, it would be the ſame as enjoining their correction and amendment; for none of the common tables can execute ſuch a demand.

It is as certain, that the coincidence of a full moon with the 29th of Thoth, happened in the year of the aſtronomical Julian period 3287, in connection with the 27th year from Nabonaſſar, and that it cannot poſſibly, in nature, be found in any other year of the period, as that there is a ſun and moon in the expanſe of the heavens.

Upon ſuch arguments as theſe, the certainty of aſtronomical chronology depends.

FINIS.

G.R III

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